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A DISSERTATION
ON THE
PROXIMATE CAUSE OF INFLAMMATION,
WITH
AN ATTEMPT
TO
ESTABLISH A RATIONAL PLAN OF CURE.

Submitted to the examination of JOHN ANDREWS, D. D. Provost, the Trustees, and Medical Professors of the University of Pennsylvania, on the twenty-fifth of April, 1811.

FOR THE DEGREE OF DOCTOR OF MEDICINE.

BY ALEXANDER H. STEVENS, A. M.
OF NEW-YORK.

Honorary member of the Medical Society of Philadelphia, and member of the Philomedical Society of New-York.

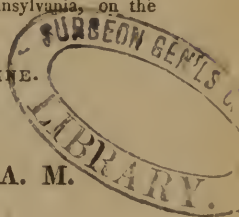
Medicus et Philosophus in omnibus quæ circa corpus humanum eveniunt mutationibus, ex claris principiis veras conclusiones et connectiones conficere et elicere debet.

Fred. Hoffm.

Principles in Medicine are the only safe and certain guide to successful practice.

Rush.

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1478
TO EDWARD MILLER, M. D.

**Professor of the practice of Physic and Clinical Medicine
in the College of Physicians and Surgeons of the Uni-
versity of the State of New-York, and,**

TO BENJAMIN RUSH, M. D.

**Professor of the Institutes and Practice of Medicine in
the University of Pennsylvania,**

**This Dissertation is respectfully dedicated, in testimony
of their acknowledged talents and worth, as well as of
the grateful sense of their kindness to their friend and
pupil,**

THE AUTHOR.

391008

THE HISTORY OF THE

REIGN OF

CHARLES THE FIRST

BY

JOHN BURNET

OF THE UNIVERSITY OF OXFORD

IN TWO VOLUMES

LONDON

Printed by J. Streater, at the Sign of the Gun, in St. Dunstons Church-yard

1679

By Authority

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PREFACE.

THE publication of an inaugural dissertation not being now required by the laws of the University of Pennsylvania, and being withal so uncommon, seems to indicate, on the part of the author, either a degree of vanity to see his writings in print, or a presumption that they contain something worthy of public inspection. The author of the following sheets is well aware of these reflections. He has, notwithstanding, ventured to appear before the public, not from any confidence he had in his own judgment, but in compliance with the advice of two of his medical preceptors, who have been pleased to say that the facts stated by him are important, and lead to useful practical results in medicine.



A DISSERTATION, &c.

MANKIND have ever been prone to extremes. From the earliest periods in the records of Medicine, we find them vibrating between the highest degree of empiricism and the total disregard of experience. To avoid equally each of these errors, to apply in unison with each other, the external and internal senses to the advancement of the most noble of all arts, constitutes one of the most dignified employments of which we are capable.

If the following observations should add to the stock of our correct notions on the subject of the proximate cause of inflammation, I shall be amply rewarded by the consciousness of their utility; if, otherwise, it will still not be thought amiss, that a candidate for Medical honours should proffer to his respected *Alma Mater* these first fruits of his labour, in this too little cultivated field.

In medicine, as in all other sciences, there are a few great principles which are the cardinal points of its application to the arts depending upon it. One of the most important of these, is the doctrine of inflammation.

Hippocrates has justly said, that the treatment of acute diseases shows most perfectly the skill of the physician.

The greater portion of these are febrile diseases, some of which are entirely dependent upon, and all intimately connected with topical inflammation.

Inflammation is the element of the most dangerous diseases. It is a morbid oxygen supporting a combustion which reduces us to ashes. Of this probably man first died, and who can promise himself to escape its dangerous influence?

If such then be the frequency, and such the fatality of inflammatory diseases, it will not be deemed uninteresting to take a brief view of the doctrines which have prevailed with regard to the nature of inflammation: to point out its most usual seats, and to explain the anatomy of the parts connected with it—to mark the persons most obnoxious to its influence, and the circumstances which occasion its attacks—to notice more minutely the various symptoms which attend it in all its stages and modifications, and briefly to mention some of the agents which aggravate or abate them.

If, in this general view of the subject, the existence of one common cause be shown to be necessarily connected with the phenomena which take place—if a succession of effects be perceived which can be traced to such common cause, no one will hesitate to believe that this is the essence of inflammation; nor can it be doubted that a rational plan of cure, founded upon well established theory, will be an object of highly important application to therapeutics.

The method of induction is conceived to be better adapted to the discovery of medical truth, than the analysis which leads to numerical certainty. Medicine cannot boast of those axioms which support the superstructure of the mathematician. The industry of its cultivators, is best exercised in comparing facts, derived from observation, and drawing probable inferences from collateral circumstances.

The most invariable symptoms of inflammation as commonly laid down, are * heat, swelling, redness and pain. In the course of this essay I shall endeavour to prove, that swelling, heat and redness are not the constant attendants of inflammation; but that the highest grade of it is accompanied by coldness, paleness and diminution of bulk, and that such symptoms occur in every inflamed part.

Inflammation has been defined to be an increased determination of blood to a part, accompanied by a morbid action of the vessels. How far this definition is correct, we shall have occasion to notice hereafter.

The most ancient idea of inflammation was that of a combustion. This we know from the writings of the Greeks, (and what is more, from their language, which is older than their writings,) to have been their opinion. From the conceived analogy between inflammation and burning, it is probable they first expressed both by the same term, *φλεγμον*; though *φλεγμανειν* its derivative, was limited to the expression of the action of burning.

Hippocrates seems scarcely to have passed the threshold of inquiry into the causes of inflammation.

* *Signa vero inflammationis sunt quatuor; calor et tumor, cum rubore et dolore.* *Cels. Edit. a Targae p. 22.*

From a remark* which he has made in his book *De Capitis Vulneribus*, it would seem, that he considered it merely an increased flow of blood into any part. Some of his followers, however, refining upon the notions of their master, held that inflammation arose not only from an excessive flow of blood, but of every sharp, glutinous and pituitous humour; to which imaginary agents they chose to assign the production of its different varieties.

Erisistratus, a man no less remarkable for the antiquity of his writings, than for his peculiar †doctrine of fever, supposed that inflammation was owing to the ‡escape of the blood from its proper vessels, into those destined to contain the animal spirits: for such was supposed, in his time, and for a long period after, to be the function of the arteries.

Rapidly passing over these vague hypothesis, which deserve little notice, but as showing the range which the human imagination will take, when unguided by judgment, I proceed to the climacteric of extrava-

* *Partes ulcus ambientes inflammantur ac intumescunt propter sanguinis influxionem.* Hip. de Capitis Vulneribus.

† Quo magis erravit Erisistratus qui febrem nullam sine hac esse dixit.—*Cels. a Targae p.* 118—119.

This doctrine has lately been revived by Messrs. Wilson, Clutterbuck and others.

‡ *Alia sanguinis in eas venas quæ spiritui accommodatæ sunt, transfunditur et inflammationem quam Graeci phlegmonem vocant excitat, eaque talem motum efficit qualis in febre est: ut Erisistrato placuit.*

Cels. ut antea.

gance, the opinion held by * Galen and his followers.

† “ When an unusual quantity of hot blood is driven into any part of an animal, the large vessels are forthwith distended, and these becoming incapable of containing more, it then passes into those which are smaller. When the smaller vessels are full, it is transuded into the interstices of the neighbouring flesh, and putrifying there produces morbid heat.” But the chimeras of Galen do not terminate here. This “ master spirit,” conjures up a host of humours into existence, to

“ Do his bidding and abide his will;”

which, like so many malicious demons, preside over the various forms of inflammation, and perform the several duties assigned to them, in this pathological phantasmagoria. The production of exquisite phlegmon was assigned to *pure hot blood*. *Bile* waved his wand, and the fiery Erypelas appeared: the bloated form of Edema slowly arose at the incantation of *Pituïta*. As these effects were slowly, or suddenly produced in any part, a defluxion, or a congestion as the case might be, was the consequence. According to this hypothesis, the indication of cure was to produce a revulsion, or derivation, as the case might be, of the peccant humour to which the disease was attributed. The discovery of the circulation of the blood, by the immortal Harvey, banished these fanciful doctrines. As derivation and revulsion were shown to be incompatible with the quick motion of the blood, in the round of circulation, so the

* Galeni Opera omnia:—passim.

† Buserius.

office of preparing and propelling it, assigned to the liver, was found to be irreconcilable with the true function of the heart.

From the noxious influence of fermentation, which alchemy strangely transferred from the alembic to the vascular system, medical opinion next sought refuge in the *Hydraulic Machine* of Boerhaave.

The *Anima Medica* and *Archæus* of Stahl and Van Helmont, and the *Vis Medicatrix* of Hoffman, did not enjoy their full share of importance until the time of Cullen.

There is not the least reason to believe that any thing like fermentation does take place in the blood of a living animal. Indeed, it is absolutely inconceivable that it ever can; when it is considered, that the blood is a vital fluid, circulating constantly, in a healthy animal, through every part of the body, and forming living parts; and that the least extraneous matter introduced into the sanguiferous system, (and such we may see Sydenham refers to, as causing topical inflammation,*) has invariably proved a cause of instant death; or of such violent symptoms, as plainly to demonstrate that any considerable intestine motion of the blood, in which its integrant particles acted upon each other, or were acted upon chemically, by foreign matter, was entirely incompatible with life.

* Now, though a pleurisy proceed from a peculiar and specific inflammation of the blood, yet it sometimes succeeds fevers of whatsoever kind they be: occasioned by the sudden translation of febrile matter to the pleura or intercostal muscles."

Rush's Sydenham, p. 177.

Boerhaave, who possessed all the learning of the age in which he lived, and which is particularly distinguished for the cultivation of mathematical knowledge, employed his talents in the formation of a theory of inflammation, more specious than any which had hitherto been offered. Leeuwenhoek, some time before, imagined that he had discovered six series of globules, each fitted, in the healthy state of a part, to be transmitted through as many corresponding series of vessels. Upon these experiments, Boerhaave founded his theory of inflammation. Whenever one of these series of globules entered one of the vessels, destined only to transmit those of the series next below it in magnitude, it produced what he called an *error loci* and obstruction, which by irritating the heart and large arteries, caused in them that increase of action, which is evident in all inflammatory diseases. As he supposed the area of the heart to be greater than the sum of the areas of all the vessels carrying blood from it, the effect of this obstruction was believed to be, an increased velocity of the blood, in the arteries not obstructed. This indeed, would necessarily take place, if the heart discharged the same quantity of blood in a given time.

A lentor, or too great spissitude of the blood, was another cause of obstruction allowed by Boerhaave. But from whatever source obstruction arose, to the course of the blood in its passage from the heart, the contraction of this viscus was rendered more powerful, by the increased difficulty with which it discharged this fluid into the aorta, and pulmonary vessels. Boerhaave ex-

plained the morbid heat of inflamed parts, by the supposed evolution of caloric, occasioned by the increased attrition of the globules against each other.

This hypothesis is evidently too mechanical. It overlooks entirely the operation of the vital principle, and the change of what has since been called the *solidum vivum*. It does not account for many of the most important symptoms of inflammation; neither does it embrace most of its causes. Attrition of fluids does not produce heat. A blow can neither be a primary cause of morbid lentor of the blood, nor of *error loci*. All the different species of inflammation, too, according to this hypothesis, must, it is evident, be occasioned by some difference in the nature of the obstructing cause. But neither *error loci*, nor lentor, nor a combination of these, in all their different degrees, and modifications, furnishes a ground for the distinctions of the several kinds of simple inflammation; much less does it afford any satisfactory account of specific inflammation; nor have we the least shadow of reason to believe the existence of a morbid lentor, in many cases of inflammation. The gluten which rises to the surface of blood, drawn from patients labouring under inflammatory diseases, exists equally in that of the most healthy persons. But further, obstruction alone, cannot constitute the essence of inflammation; because it often arises from aneurisms, and may at any time be artificially produced without inducing inflammation. The whole hypothesis is predicated upon the supposition that the area of the heart and arteries forms a truncated cone, of which

the heart is the base, and the arteries the section nearest the vertex. Precisely the reverse of this has been proved to be the case; inasmuch as the sum of the squares of the diameters of all the vessels proceeding from the heart, or from any arterial trunk exceeds the area of the heart, or vessel giving off branches*.

Gorter, a pupil of Boerhaave, denied that obstruction did take place at all, and referred the phenomena of inflammation to an increased "*vital motion*." This explanation differed only in the terms by which it was expressed from the "*tonic motion*" of Stahl.

Hoffman asserted that obstruction took place in consequence of spasm†. Further than this, it does not appear that he gives any explanation of the cause of inflammation. He indeed, as well as his follower, Dr. Cullen, invokes the *Vis Medicatrix Naturæ* to assist him in explaining many of the attendant symptoms. But whether we give intelligence to this imaginary principle, or merely understand by it a *physical necessity*, it is equally evident in either case, that we are as much in the dark as ever.

* Circles are to each other as the squares of their respective diameters.

Euclid Lib. xii.

† Inflammationis hujus proxima causa sanguinis vel etiam seri impuri in extremitatibus arteriolabus stasis est, qua sanguifera per vesicæ tunicas discurrentia vasa a sanguine copiosus congesto nimium replentur, distenduntur et nervosa exquisitissimæ sensationis tunica, in vehementem *spasmus* abripitur: ex quo reliquorum symptomatum origo.

Hoffm. Oper. Omn. Lib. iv. Sec. ii.

In the first place we are referred to an imaginary intelligent principle, existing in the body, independent of the soul, and occasioning all our diseases, and even death, by its ill directed efforts to preserve the body; and whose operation, reason, which was surely given us for our preservation, often directs us to oppose! In the second, we have what, perhaps, is better, as less likely to mislead, the simple expression of the fact.

Dr. Cullen advocated in so plausible a manner this doctrine of inflammation, and brought it so much more into respect than it had ever been before his time, that his explanation may, perhaps, deserve a separate consideration. **"Some causes of inequality,"* says that celebrated physician, "in the distribution of the blood may throw an unusual quantity of it upon particular vessels to which it must necessarily prove a stimulus. But further, it is probable that to relieve the congestion, the *Vis Medicatrix Naturæ* increases still more the action of these vessels; and which as in all other febrile diseases, it effects by the formation of a spasm upon their extremities. A spasm of the extreme arteries, supporting an increased action in the course of them, may therefore be considered as the proximate cause of inflammation; at least in all cases not arising from direct stimuli applied; and even in this case the stimuli may be supposed to produce a spasm of the extreme vessels."

'An inequality in the distribution of blood' may take place without inflammation. Now as ef-

* Cullen's First Lines of the Practice of Physic. Sec. 244. et sequent

fects must always uniformly follow their causes, 'an inequality in the distribution of the blood' must be considered, not of itself a cause of inflammation, as Dr. Cullen makes it, but as an effect either of inflammation, or a collateral effect of a common cause.

As this forms the link which connects spasm with the explanation, it might be sufficient to show that Dr. Cullen had mistook an effect for a cause, in forming the groundwork of the hypothesis. But overlooking the error into which we are led by believing, that a cause of disease exists only, after many of its symptoms have appeared; or that spasm, supposed to be the cause of inflammation, takes place to relieve congestion—mistaking the *vis medicatrix naturæ*, for the power of an argument, to preserve the medical body corporate, from pathological scruples—we are puzzled to see how spasm can have the desired effect of relieving congestion. We fear lest, after a short examination before the tribunal of impartial reason, spasm be found an idle boy, quite unfit to execute the orders of the fickle dame that sent him.

The causes of congestion are either an increased afflux of blood to a part, or a slower transmission of it through its vessels. Whatever diminishes the one, or increases the other of these, relieves it. In what manner can a spasm of the capillary vessels produce either of these effects? Diminishing or actually obliterating the diameters of the small arteries, renders the transmission of blood more difficult;* nor is it easy to

* If the diameters of the capillary vessels be merely diminished, without being entirely obliterated, the small quantity of

perceive in what manner it can proportionably lessen the afflux of blood to an inflamed part. If the existence of spasm were proved, it would rather aggravate, than abate, congestion.

John Brown made all diseases consist, simply, in an increase, or diminution, of natural action. Inflammation, according to his theory, arises from too great, or too little, excitement in a part.

But, surely, no alteration in the degree of the action of the vessels, could give rise to secretion, in which inflammation so often terminates. How can an agent, which only increases, without altering, the healthy action of the vessels, form a callus for the union of a fracture, or pus from an ulcerated surface? If the justness of this doctrine be allowed, secretion becomes mere filtration; and, by a parity of reasoning, absorption is proved to be nothing more than the effect of capillary attraction. Brown's theory, or any extension or modification of it that can be made, will not afford the least clue to the explanation of the phenomena of specific inflammation. It, moreover, makes the same disease

blood, which enters them will, indeed, pass on more rapidly; but still the amount transmitted must be less. To relieve this state of the vessels, we should increase the action of the heart by stimulants. Those of a diffusible nature are, in general, found best to accomplish this purpose, as they do not increase the violence of the hot stage which follows.

These are the means which are universally used to shorten the cold stage of febrile diseases, particularly of idiopathic fevers; and on the other hand, the influence of sedatives and stimulants, in the order I have named them, is the most common remote cause of inflammatory diseases.

depend upon opposite states of a part. Active inflammation, he supposes, to be merely a rising of healthy excitement above, and passive inflammation, a sinking below, the salutary point of his pathological thermometer. But who ever saw a part pass the line of health, in sinking from the elevation of active, to the depression of passive inflammation; or the reverse of this? We often see fevers inflammatory in their commencement, and typhus in their progress. In such cases, there is increase and diminution of action, in the same patient, at different periods of his malady. But Brunonian optics have never been keen enough to detect nature at the critical moment, when she passed the healthy state, in her progress from sthenic to asthenic inflammation.

John Hunter defined inflammation to be "an action of dilitation," "an increased relaxation of parts," "an action of the parts to produce an increase of size, to answer particular purposes," "an increased relaxation in the parts," "being, as he thought, left to elasticity altogether." &c. &c.

The first and second of these explanations, if indeed it be not a misnomer so to call them, merely expresses the fact, that increase of the diameters of the smaller vessels does take place. This no one will deny. But, surely, it is not to be considered a cause of inflammation, although it may generally attend as a symptom. Shall we say, then with Hunter, that inflammation is an action of parts to produce an increase of size; or a renewal of deficiencies, to answer particular purposes in the animal economy? Suppose we do; is any new idea

derived from such an explanation? I think not. To say that an action of parts takes place, because such an action is useful, or necessary, is, so far as regards rational explanation, to say nothing. In the elucidation of physical phenomena, we are to point out the *means*, which the Deity uses, to accomplish his purpose. But Mr. Hunter refers us immediately to the *will* of the Deity; and we might as well say, as he in substance does, that inflammation is an action of parts, produced by the will of the Deity; for it is clear that all the purposes of the Deity are useful. This mode of accounting for inflammation, would be exactly analogous to that of the philosophy of Greece and Rome, which referred the rise of water in tubes, when the pressure of the atmosphere was diminished, or removed, to the abhorrence in which nature held a vacuum.

Sensation, whether of pleasurable or painful nature, according to the hypothesis of Darwin, is the cause of "new motions, which constitute inflammation*." But it is indisputable that "new motions" of the affected organ, are *not always* generated in consequence of a sensation of pleasure or of pain. So far from this is the fact, that the highest degrees of pleasurable sensations in a part, are never, in the ordinary course of nature, followed by those new motions, which, according to Dr. Darwin, are termed inflammation. Pain and pleasure, which last however we seldom experience in parts inflamed, are not perceived, until after the complete establishment of the disease. Sensations, therefore, whether pain-

* New motions of the affected organ are generated in consequence of the pain or pleasure, which constitutes inflammation.

ful or pleasurable, are to be considered as symptoms, not as causes, of inflammation.

Dr. Fowler published in 1787, his *Quædam de Inflammatione*. The doctrines he maintained were not new, though his defence of them was probably the most able, that had at that time, been made. He adopted the opinion of Gorter, that inflammation depends upon an increased action of the capillary vessels. When the causes of obstruction which had been assigned by Boerhaave, were proved to have no existence, it was taken for granted, too, that obstruction did not exist. Hence Dr. Fowler considered the fact to be well established, that the velocity of the blood through the inflamed parts is increased; and from this error a conclusion no less erroneous was drawn, that the action of the capillary vessels is increased by inflammation.

Messrs. Allen and Lubbock, in the Medical Society of Edinburgh, about twenty five years since, advanced, and supported a theory, directly opposed to the notions then prevailing, upon the subject of the proximate cause of inflammation. They contended that inflammation is always attended by relative debility of the muscular powers of the capillary arteries. Dr. Wilson has since very ably defended the same opinion*. Neither of these gentlemen seem to have been aware that Prof. Vacca Berlingherii had, so early as the year 1765, laid down the same position. Another learned writer† tells his readers, without meaning at all

* Wilson on Febrile Diseases. Class, Phlegmas.

† Parr's Med. Dict. art. Inflammation.

to derogate from the credit of Messrs. Allen and Lubbock, that he had long held the same opinion. Dr. M'Lean* remarks that he communicated an opinion similar to that which I have mentioned, with regard to the proximate cause of inflammation to Dr. Duncan, in 1793, and until the time of his publication (1809) conceived his ideas on the subject to have been entirely original. Latta has very briefly advocated the same opinion, without any notice of its original author. Inflammation, says he, "must appear to rather consist in a paralysis, than a spasm of the vessels immediately affected." Lerney on Local Inflammation and Ophthalmia, notices the same opinion; but is altogether silent on the subject of its probable author.†

Some of these writers must, no doubt, be considered as independant witnesses to the truth of the doctrine, that debility is an invariable attendant upon inflammation—and so far as it goes, the fact is *prima facie* altogether in favour of the correctness of the theory. But in deciding the question of its original author, we may say with the poet:

"Non nostrum inter vos tantas componere lites."

However dates speak for themselves; and Vacca no doubt is entitled to the praise of having, among a number of fanciful notions, derived from the age in which he

* M'Lean on Hydrothorax. "In inflammation the action of the heart is frequently increased very considerably, while that of the inflamed vessels is always diminished." p. 257—8.

Prop. 1. † System of practical Surgery by Latta, 1804, p. 4. et sequent.

lived, entertained opinions on the cause of inflammation, more correct and more reasonable than any of those of his predecessors*.

Were we pointing out the achievements of the descendants of Esculapius in exploring the pathology of inflammation as did the spirit of Anchises, of the Cesarean ancestry to the hero of the Roman poet, well might we exclaim of Vacca,

“Tu Marcellus eris.”

Nor would he less deserve this mead of praise, than he who was honoured with the verse.

* *Prop.* 1. Inflammatio cujusvis partis humani corporis nunquam sit, nisi in ipsa parte sanguis coarcervetur et fere quiescat.

Prop. 2. Coacervatio et semistagnatio sanguinis, vel alius humoris corporis humani, in quamcumque ipsius corporis parte minime contingere potest, sine *ipsius partis absoluta vel relativa debilitate*.

Prop. 3. Data eadem partis cujusdam debilitate, non solum coacervatio, et semistagnatio, sanguinis fiet in ipsius partis sanguineis vasculis, ut demonstratum est, verum etiam canales laterales lymphaticas, et adiposos ipsius partis sanguis ingredi debet.

Prop. 4. Ex majori collectione sanguinis in vasculis sanguineis alicujus partis, et ingressu ipsius in canales tam lymphaticas quam adiposos, et ex ejusdem sanguinis per ipsos, atque sanguineos canales lentissimo motu, inflammatio morbos in eadem parte oriri potest.

Prop. 5. Ex majori sanguinis in parte quacumque inflammatione, inflammatio pinguidenis compositæ, et in ea parte existentis, exorietur.

Prop. 6. Ex enata inflammatione in aliqua humani corporis parte major sanguinis, et humorum quantitas in eadem partem influit, atque ideo tumor necessario major fieri debet.”

Prof. Vacca, Berlingherii.

Seat of inflammation.

Inflammation may take place in any part of the body in which there are vessels not, in their healthy state, carrying red blood. It arises most frequently in parts, which have the greatest number of such vessels, allowing readily of distention, and which are farthest from the centre of the circulation. The nails, hair, and cuticle, not being vascular, are never attacked by it. The bones, medullary substance, tendons, &c. are not so often the seats of it as the cellular tissue, the muscular fibre, and the glands.—Of secreting surfaces, which are, in general more liable to inflammatory affections than nonsecreting surfaces, the mucous are perhaps the most obnoxious to its influence.

Anatomical account of the parts concerned in inflammation.

The heart is an organ entirely muscular. The arteries proceeding from it are partly muscular and partly ligamentous. As we descend from the larger to the smaller branches, the ligamentous coat diminishes more, in proportion to the size of the artery, than the muscular one. Mr. Hunter has conjectured that this last exists alone, in the smaller arteries: the ligamentous coat being entirely wanting in them. The large veins have a pulsatory motion; whence it is inferred, that they possess muscular fibres. But the reverse of what exists in the arteries, is found to obtain in them; for the largest seem to possess the greatest, and, perhaps, the only share of muscular power.

The design of this arrangement is evident. The blood as it comes immediately from the heart, has a sufficient impetus to render unnecessary to its propulsion the exertion of much muscular power. But as it proceeds onward, through the arterial ramifications, it gradually loses it momentum, from the resistance it meets with by friction against the sides of the vessels. Muscular power thus becomes more and more necessary to its motion; while, at the same time, the increased area of its channels, does not require it to advance with its former velocity, in order to the passage through them, of all the blood coming from the heart: according to a well known principle in hydraulics.

As elasticity is that property of bodies, which disposes them to resume their shape, after it has been altered by the application of any power, with a force equal to that which produced such alteration; it is evident, that so far as the ligamentous coat of the arteries possesses this property, the momentum of the blood, which had been opposed, during their expansion by its elasticity, is returned by the contraction of the vessels, with the force of this power.

If there be no fallacy in this view of the subject, it would appear that the elastic coat of the arteries is not directly concerned, either in retarding, or accelerating, the motion of the blood. Its action is entirely through the medium of the muscular coat; moderating that distension, which a diminution of the muscular power of the capillaries, or an excessive action of the heart and larger vessels necessarily causes; and obviating that

tendency to obliteration in the minute arteries, which an increased exertion of their muscular power over the counteracting force of the blood, *a tergo* would otherwise occasion.

The first of these states of the vessels, is denominated inflammation. The latter is well exemplified in those appearances, which we observe in the cold stage of febrile diseases; and which, I presume, exist in the minute vessels, previously to the occurrence in them of inflammation; whether induced by the application of topical stimuli, or other causes. It is attended by diminution of bulk and heat, and by paleness, obstruction of perspiration and secretion. For the want of any term in our language to express it, I shall call it the *anaimatous** state of the vessels.

Dr. Rush mentions, in his lectures, violent cases of ophthalmia, in which no redness, or indeed any other symptom of inflammation, except great pain, was perceived. Coagulable lymph is not secreted to unite solutions of continuity in any part of the body, until a moderate degree of inflammation has supervened. There are acute febrile affections of the liver, so violent, or in which, as Dr. Rush says, the excitement is so far beyond the point of inflammation, that no secretion of bile or appearance of inflammation is perceived. By bleeding, and the pursuance of the antiphlogistic regimen, inflammation is brought on. There are many such instances upon record, which it would be useless to enumerate. It will be allowed, that there is an affection of the sanguiferous system different from inflammation without in-

* Derived from *αναιματος*, exsanguis.

deed any of its symptoms; but more severe and fatal. This, I conceive, in a lesser degree, to take place after every application of the remote causes of inflammation. It is usually of so transient a nature as to pass unobserved, but in the cases mentioned by Dr. Rush, and others, it attracted particular notice from the violence of the symptoms, and from the apparently natural state of the parts. These were cases of the *anaimatous* state of the vessels. The excitement of the capillaries was not *beyond* inflammation; but on the other side of the scale.

To establish these positions, I may premise, that the phenomena of organic life irresistibly lead us to agree with Brown, that all positive agents are stimuli,—that the uniform effect of all stimuli is, first, to increase, and afterwards, to diminish, excitement. From these well established data, I proceed to lay down and illustrate a few propositions, upon the most simple affections of the vessels: viz. the states of the capillary vessels during the periods of *anaima* and inflammation. Let us suppose some topical stimulus, such for instance, as fire, spirits of turpentine, or electricity, to have been applied.

Prop. 1. The state of *anaima* is the first state of the vessels after the application of local stimuli.

Demons. The effect of the stimuli, which induced inflammation, must be, primarily, to increase the action of the vessels to which they are applied. This increased action must induce paleness, diminution of bulk, and a train of symptoms which indicate the *anaimatous* state of the vessels. Because the office of the vessels is to propel the blood onwards, and, therefore, the greater their action, the more quickly will the blood pass on;

and hence, with a given supply of it, little will remain in the inflamed vessels.

It is surprizing that the state of inflammation should, in place of this *anaima* have been considered to be the first effect of topical stimuli. One would have thought that physicians, enlightened by the torch which Brown so brilliantly displayed, would not have passed over that state of the vessels, which the fundamental principles of his doctrines so incontestibly prove to exist.

To this first proposition, which I have endeavoured to establish, it may be objected, that if this state of *anaima* really intervene, between the application of local stimuli and inflammation, how has it happened to have passed so much unnoticed. The objection, I trust, may be easily removed. I have observed, that the smallest capillaries possess the greatest share of muscular fibre, and the larger vessels the greater proportion of ligament in their composition.

Now, muscle is irritable, and ligament is not so. When local stimuli, therefore, are applied, the smaller vessels at first will be most excited, and, consequently, run soonest into a state of debility. Hence it is, that the state of redness and inflammation so soon succeeds this loss of equilibrium between one set of vessels, and that immediately next it, in magnitude, as to have been erroneously thought to be attended with increased action; or in other words, to be a *primary* effect of the application of stimuli. When fire, or turpentine, &c. are applied to the skin, it affects directly the most minute vessels. The others are influenced by sympathy entirely. But there are other agents, such as electricity and galvanism, which are conducted by the nerves of a

part, so as to affect with an equal force, *all* the vessels in its neighborhood; and when these are applied, as I have often had occasion to witness, they do not so quickly induce inflammation, as some other topical stimuli of less power.

Prop. 2. To the *anaimatous* state of the vessels succeeds a state of relative, and, in most cases, of absolute, debility of the smaller arteries; which is inflammation.

Demons. To ascertain the last of these positions, so much the reverse of most opinions which are now prevalent on the subject, I determined to repeat some of the experiments of Dr. Wilson, and to make such others as might seem best calculated to throw light upon this subject.

As it is acknowledged on all hands, that the action of vessels, more particularly of the capillary arteries, is to propel the blood forward in the course of the circulation; so it is equally true, that the greater the action of these, the less will be the quantity of blood in them; and hence a partial or total obstruction can arise only from debility. If this be allowed, the inference from the following experiments, will be clear and decisive.

I omit altogether reasoning a priori on the state of the vessels during inflammation, though it will readily occur to every person, that inflammation is a state of debility of the minute capillaries, if the observations under the head of proposition 1st prove, as I believe they do, that the state of increased action, preceding inflammation is attended with paleness, and increased velocity of the blood.

Exp. 1st. The web of a frog's foot, which had been previously exposed to a considerable degree of heat, so

as to produce inflammation, was placed in a solar microscope of great power; and the image, which was received on a white surface, placed in a suitable position, displayed very beautifully the circulation of the blood in the web. That I might not be deceived by my own expectations, as to the probable result of the experiment, I directed my assistant to observe the comparative velocity of the blood through the small inflamed spot and the adjacent parts of the web. Although totally ignorant of what would probably take place, he immediately remarked to me (who was engaged at that time in adjusting the web) that "the picture seemed to be moving all over;" but much less in a spot about the centre of the image which was more opaque than the rest. This part he pointed out to me, and I readily recognised in it that through which I had previously run a hot pin. He compared the appearance altogether, to the motion of a stratum of small shot on the bottom of a pail, when turned round and then suddenly stopped, and said he could make the two appearances precisely similar, if he were to flatten a few shot in the centre of the stratum so as to prevent them from moving so much as the rest.

Exp. 2d. The same web of this frog was immersed for a short time in hot brandy and again exposed to our view through the microscope. The motion of the globules was not at all discernable through the inflamed spot; but in the parts next it, which had not become opaque, and where the inflammation had just commenced, the retardation of the blood was perfectly evident.

Exp. 3d. I made another experiment with a healthy web, in order to ascertain if the motion of the blood in

the vessels about the parts which I had inflamed, was similar to that in a healthy web. I expected to have found it different; but the most careful examination I was able to give the subject, did not enable me to say that it was so; the globules seemed to move with equal velocity in each.

Exp. 4th. The day following experiment 1st. I used the web through which I had passed a hot pin, &c. to learn the state of the circulation through it. The semistagnation and opacity had extended over a larger surface than before. Through the whole of the web indeed the motion of the blood was seen to be more slow than on the day preceding. I applied spirits of turpentine. This evidently spurred forward the globules for a moment, but they soon resumed their former inactivity.

Exp. 5th. I endeavoured to view the motion of the blood through the semidiaphanous skin of a frog's belly, by detaching it from the parietes of the abdomen. This was done in such a manner as to cause no visible effusion of red blood. The experiment however failed, as the part did not prove sufficiently transparent for my purpose.

Exp. 6th. The transparent membrane of the tail of a small fish was placed in the microscope in order to see the state of the circulation. But the animal died so quickly, that the experiment was completely frustrated.

I regretted very much my want of ability to procure a microscope of greater power than those which I made use of. To this circumstance I attribute my not having seen the motion of the blood in the *anaimatous* state of the vessels: as they did not permit the entrance of globules of sufficient magnitude to be visible.

The experiments which have been related more particularly the first and second, were repeated several times, and the circulation viewed by indifferent persons, all of whom agreed that a partial stagnation took place in the inflamed web.* I have to regret, however, that the season of the year did not allow me to pursue my inquiries to the extent I wished. They seem to

* The length to which this dissertation has already been protracted, renders it a task to select rather than to multiply arguments in favour of the position that obstruction does take place in inflamed vessels. The following fact, however, the first that led me to think on the subject, seems to me so apposite that I cannot omit mentioning it: perhaps, indeed, it deserves a less equivocal notice in the body of the essay.

A year or two since, when fishing off Sandy Hook, I raised a hallibut over the side of the vessel; ere he had reached the deck, he extricated himself from the hook, and fell down the chimney, which did not extend above the plank of the quarter.

Some hot embers upon which he fell, excited inflammation on the white surface of the belly of the fish. I was surprised to find the colour of the inflamed part so different from what I supposed to be the colour of the mass of his blood. To ascertain this fact, as well as to put him out of misery, his throat was cut. The blood, which flowed from the divided vessels was extremely different from that of the inflamed part, seen through the transparent skin of the fish. Did this blood, let me ask, circulate freely with the general mass, when the fish was alive? How could it undergo, in a *rapid* passage through the vessels, that operation which produced this great change of colour? The same difference of colour may be observed in the bruised and inflamed fins and tails of fish, in the New-York market, at all seasons of the year; and in an equal degree in that of Philadelphia, when live fish are seen here. It is somewhat nearer the vermilion colour than that of an orange, but between the two.

me, however, very completely to establish the fact for which I contend—*viz.* That the blood circulates unnaturally slow in inflamed parts: and from this is derived my chief support of the second proposition, that inflammation is a state of debility of the minute arteries.

Inflammation may take place in cases where the action of the heart is greater than in health—where it has just its healthy force—and where its action is weaker than in health. Constituting

1. Inflammation with fever;
2. Inflammation without fever;
3. Passive inflammation.

Inflammation cannot be considered a state of the vessels in which the excitement of the capillaries is merely diminished. It is accompanied by morbid action. This, I trust, has been rendered sufficiently clear. (Vide p. 18, et seq.)

We may therefore define inflammation to be a *state of relative debility of the small* vessels,† attended by morbid action.*

* Is not inflammation analogous to that state of a large vessel which produces anurism?

† I purposely say *vessels* rather than *arteries*, because I believe that debility of the *veins* sometimes constitutes an essential part of inflammation. This, I suspect, is more especially the case, where a vein arises from an artery, in common with an exhalent. One of the channels which should receive the contents of the artery, being thus obstructed, a larger portion of blood is diverted into the other, (the exhalent,) thus giving rise to that increased secretion, which attends inflamed secreting surfaces.

An account of the Pathognomonic Symptoms of Inflammation.

The *swelling* of inflamed parts, arises from an increased quantity of blood in vessels, not naturally destined to contain it. This is proved by its following too immediately the application of exciting causes, to render possible the formation of new vessels, and where no breach of continuity can be suspected to give rise to effusion. Mr. Hunter froze the ear of a rabbit, and thawed it again; and inspecting it with a microscope, he perceived a want of transparency, which was justly attributed to the secretion of coagulable lymph. This must, no doubt, in this case, have occasioned in part, the increased bulk of the ear. But in the first stages of inflammation, it cannot be secreted soon enough to cause any of the swelling.

The *redness* of inflamed parts has been attributed to a want of power in the vessels to abstract carbone, or to produce those changes which distinguish venous from arterial blood.

In man, the colour of inflamed parts differs from that of the mass of the blood, much less than in cold blooded animals. The blood of the arteries of fish, is of a bright vermilion; while that of inflamed parts in them, is of a pale yellowish red. Did not partial obstruction exist, the anastomosing and other arteries, around inflamed spots, particularly if they were small, would so mix the blood, that their peculiar colour would soon be lost in that of the general mass.

The *throbbing* so evidently arises from the passive distention of the small vessels, that it needs no explanation.

The *heat* of inflamed parts is either relative or absolute. The relative heat varies much, according to the nature of the part affected. It is less in secreting parts than in others. Secretion induced in an inflamed surface which naturally secretes, diminishes the sensation of heat. The absolute heat seldom rises higher than five or six degrees above the natural standard; though the sensation in the part itself, as well as that which it communicates to the hand, would lead us to suppose it much greater.

The heat of inflamed parts is sometimes below the natural standard; a livid colour at the same time attends. This occurs in commencing, and in actual mortification; and affords strong evidence of the truth of my proposition. When the motion of the blood is so slow, that the increased quantity is more than counterbalanced by its diminished velocity, then it is, that the heat begins to abate. Total obstruction now takes place. The last act of the vessels is to convert this obstructed arterial into venous blood: the part is then livid, cold, and mortified. How perfectly do these phenomena coincide with the view of this subject that I have exhibited! How irreconcilable with the notions of the present day, on the cause of inflammation! Increased action of the vessels, and a corresponding velocity of the blood, are said to take place, and constitute inflammation; and yet a cessation of action, and an entire obstruction are the very first consequences we are taught to dread!

Inflammation causes *pain* by the distention of the nerves, and in part too by the morbid action which accompanies it.

Prop. 3. Inflammation, by causing obstruction, may occasion a febrile action, in which the excitement of the heart will further increase it by distending, and debilitating the capillary vessels. In such cases, inflammation may arise in new parts without any previous state of *anaima*, other than the *relatively anaimatous* state of health.

The indication for the cure of simple inflammation accompanied with fever, are:

1. To remove the causes of debility; which is done, By diminishing the *vis a tergo*, by general blood-letting, by the application of *blisters near the inflamed part, and what is called the antiphlogistic regimen; and

By removing the blood already in the part, by the use of leeches, cups, &c. and by puncture, if the blood be extravasated. Following the use of these remedies, by the application of stimulants and tonics, in order

2. To strengthen the vessels.

Emollient poultices will also be useful, if occasion require them,

To remove the tension of the vessels.

We are likewise to endeavour

3. To establish the healthy action, which is done by the means used to restore the lost tone of the vessels, viz. the application of stimulants and tonics.

* The remarkable efficacy of blisters in stopping the progress of mortification when applied near the margin of the mortified part, justly comes under this head, for the inflammation and debility, they produce in the sound parts occasion obstruction, and thus diminish the *vis a tergo*.

When inflammation occurs without fever, topical remedies alone are necessary.

In passive inflammation, in addition to the means above mentioned, we must exhibit general stimulants and tonics.*

These heads contain only the important indications for the cure of inflammation when we aim at resolution, and these are particularly derived from the theory which I have endeavoured to establish. Those which relate to the treatment of suppurative and other species of inflammation, may be found in all practical works on the subject.

I cannot help remarking, that the means for the production of resolution, which experience has proved to be best, exemplify very beautifully, the theory which has been offered; while, on the contrary, the single fact, that LOCAL STIMULI ARE OUR VERY FIRST AND BEST APPLICATIONS TO INFLAMED PARTS, is, of itself, a host of reasons against the prevailing doctrines on this subject.

* The manner in which these operate, in strengthening and stimulating the minute vessels, rather than the larger ones, will be rendered evident, by considering what is said in page 19 et sequent.

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